DOES ARTICLE 6 HAVE A ROLE TO PLAY IN CARBON CAPTURE AND STORAGE?

At a glance:

Carbon dioxide capture and storage (CCS) will be needed to achieve emissions reductions in hard-to-abate sectors and to scale up carbon dioxide removal (CDR), both of which will be required to meet the goals of the Paris Agreement.

It is important to understand that CCS, carbon capture, use and storage (**CCU**) and CDR are distinct concepts, although they overlap in certain areas. Depending on how they are used, CCS and CCU may result in either reductions or CDR. Part of this paper is dedicated to ensuring stakeholders are on the same page in relation to these important concepts. The focus of this paper is on CCS and its interaction with CDR.

"We will always give the message that there is no solution to climate. I mean, the ambitions for 1.5 degrees or 2 degrees are so, so large that we can't actually leave anything off the table."

JIM SKEA, CHAIR OF THE IPCC
FT COLLECTIONS CLIMATE EXCHANGE, 29 NOVEMBER 2023

Putting it into context

In the challenge of achieving the objectives of the Paris Agreement, to keep the increase in global temperatures to well below 2 degrees (the **Below 2 Degree Target**), the Intergovernmental Panel on Climate Change (**IPCC**) has made it abundantly clear that we need every possible tool at our disposal to achieve that objective. In its Climate Change 2023: Synthesis Report[1] (the **Synthesis Report**) the IPCC considers carbon capture and storage (CCS) as *"an option to reduce emissions from large-scale fossil-based energy and industry sources provided geological storage is available."*[2] Yet, CCS gets a lot of bad press. This is because its detractors associate the idea of carbon capture and storage with the idea that, capturing fossil fuel emissions at source will permit the fossil fuel industry to continue to burn fossil fuels or that the enhanced oil recovery (**EOR**) benefits associated with some CCS methodologies allows for more fossil fuels to be burned; a notion that is not compatible with the Below 2 Degree Target. Therefore, other solutions such as direct air carbon capture and storage (**DACCS**) or bioenergy with carbon dioxide capture and storage (**BECCS**) have been championed which are also examples of emission removal technologies. Yet, in the technical nomenclature of the IPCC, DACCS and BECCS are considered CCS but are also considered as carbon dioxide removal (**CDR**) which is an umbrella term that involves removals of CO_2 from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products.[3] In this paper, we focus only on geological storage solutions and not on nature-based storage solutions. Further, since CCU does not involve geological solutions, we do not focus on CCU either.

So clearly a more accurate statement is to recognise that some CCS methodologies should be encouraged whilst perhaps, others should be discouraged. Part of the aim of this paper is therefore to ensure readers focus their attention on the methodology to which CCS is applied rather than start with an assumption that all CCS is bad.

Whether the methodology is a reduction or removal methodology, the extraction of CO_2 is effectively achieved and CCS *"provides the storage component of these CDR methods"*[4]. Research reveals a substantial gap between the proposed CDR and what is needed to limit warming to 2°C or lower, and estimates that "novel" CDR, including methods such as BECCS and DACCS, will need to increase 30-fold by 2030 and 1,300-fold by 2050 to meet this

At a glance (continued)

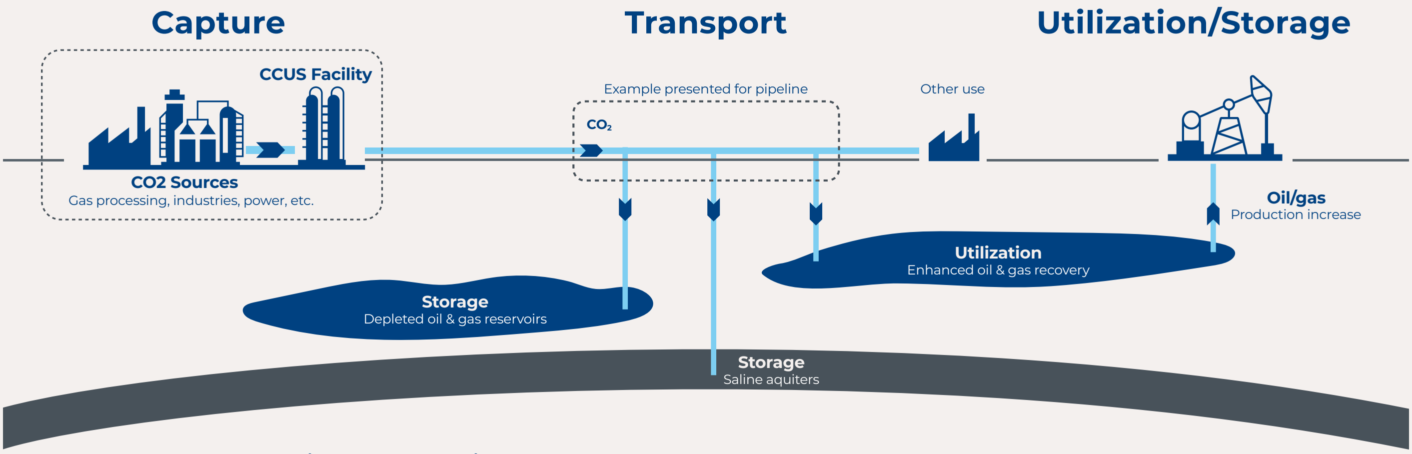
In many cases, geographical and cost factors limit the ability of CCS to be performed within the boundaries of a single country. Therefore, scaling up CCS will require significant investment and international cooperation to allow carbon dioxide (**CO_2**) to be captured in one country and transported to another country for storage. This is why we consider whether Article 6 of the Paris Agreement can support the funding of transboundary CCS. We conclude that, as it currently stands, the Article 6 rulebook is not conducive towards facilitating international cooperation in CCS. This is a shame because it deprives a number of countries of an additional tool to help meet their nationally determined contributions (**NDCs**). In particular, the accounting treatment of CCS and requirement for corresponding adjustments pose significant obstacles to using Article 6 as a mechanism to support the financing of CCS.

1 AR6 Synthesis Report: Climate Change 2023 — IPCC

2 See footnote 47 in paragraph B.6.3 in the Climate Change 2023 Synthesis Report Summary for Policymakers AR6 Synthesis Report: Climate Change 2023 (ipcc.ch)

3 https://apps.ipcc.ch/glossary/

4 *Ibid.*



Source: IEEFA, Carbon Capture in the Southeast Asian Market Context. 2022.

target.[5] CCS is also required to deliver emissions reductions for hard-to-abate sectors such as agriculture, aviation, shipping, and industrial processes *"and would need to be counterbalanced by deployment of CDR methods to achieve net zero CO2 or GHG emissions."*[6] As described by the chair of the IPCC, CCS is a technology system, with different elements, and *"the capture bit is different from the transport bit and the storage bit"*.[7] In light of this, the fundamental challenge that realists must face, is that for these technologies to be deployed at scale, a lot of investment is needed.

The implementation of CCS is frequently characterized by the assertion that it represents a costly approach to emission reduction or removal. The capital expenditure for CCS typically entails investments ranging from hundreds of millions to occasionally exceeding $1 billion. In comparison to the capital investments required for other clean energy sources like wind and solar, which operate on a smaller scale and demand smaller absolute investments, CCS may appear costly.[8] However, the cost of CCS is not uniform[9] and costs will vary due to its versatility.

Total global geological storage capacity greatly exceeds the amount of CDR required to meet the goals of the Paris Agreement.[10] A more fundamental reality is that geological storage is not always located in close proximity to sources of GHG emissions or facilities which remove CO_2 from the atmosphere, which tend to be in industrialised countries. This therefore means that, leaving aside certain countries (e.g. the United States of America) international cooperation will often be required for CCS to be implemented at scale.

Asia Pacific countries such as Singapore, Japan, South Korea and Taiwan have combined annual CO_2 emissions of 840 million tonnes but have limited viable storage sites in their own countries.[11] In some countries, such as Japan, even if there is some storage capability, its cost may be more prohibitive than it would be compared to that of another country (even taking into consideration the transportation cost).[12]

This transboundary challenge then invites consideration of how the country of capture works together with the country of storage to enable a technology system that makes the capture, transport and storage cost effective against other decarbonisation solutions that may be available. Therefore, the other objective of this paper is to consider what role Article 6 of the Paris Agreement may play in providing financial support to support CCS.

Let's get our nomenclature right

To avoid confusion, we will adopt the IPCC definitions for CCS, CCU and CDR in this paper. For ease of reference the IPCC definitions are set out at the end of this paper. It is worth noting that there are some types of CCS, such as the capture of CO_2 from a power plant or chemicals factory that relies on fossil fuel feedstocks, that simply reduce greenhouse gas (**GHG**) emissions without removing any CO_2 from the atmosphere and are therefore not CDR. There are also certain types of CCS, such as EOR or enhanced gas recovery (**EGR**), that use CCS to produce more fossil fuels and may increase GHG emissions on a net basis (unless the CO_2 from the recovered fossil fuels is also captured and stored).

CCU similarly may or may not result in any CDR, depending on the source of the CO_2 and the product being made with the captured CO_2. For instance, if CO_2 is used to make synthetic fuels,

5 See https://static1.squarespace.com/static/633458017a1ae214f3772c76/t/64d2223cab34856349188e07/1691492940765/SoCDR-1st-edition-2023-V9.pdf.

6 See paragraph B.6.2 in the Climate Change 2023 Synthesis Report Summary for Policymakers

7 Jim Skea, FT Collections Climate Exchange, 29 November 2023

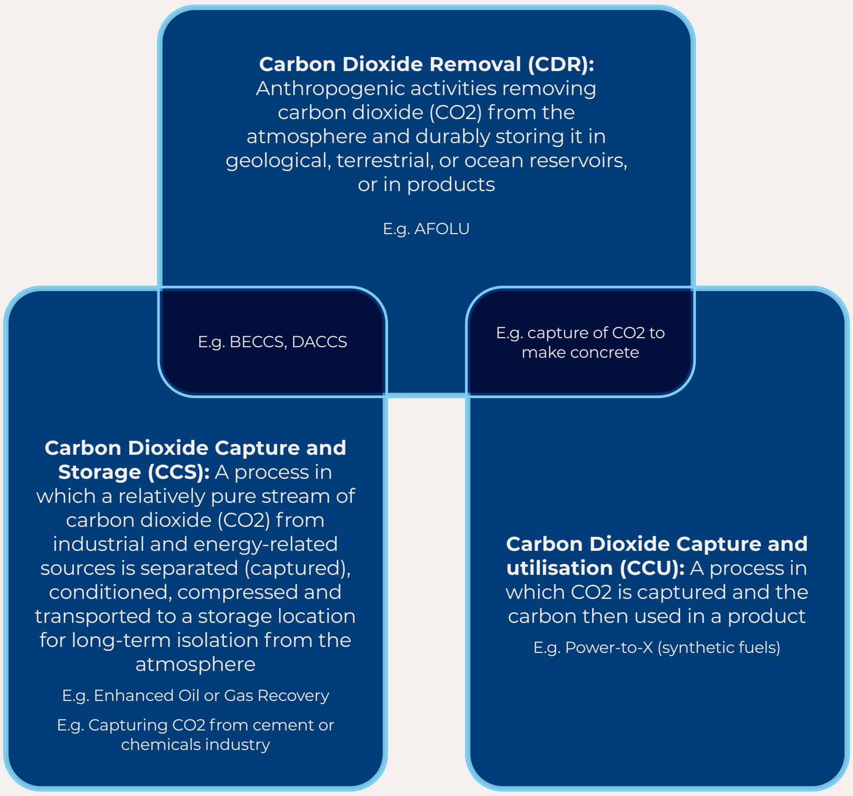
8 See Is CCS expensive? - Global CCS Institute

9 See Is carbon capture too expensive? – Analysis - IEA

10 See https://www.iea.org/commentaries/the-world-has-vast-capacity-to-store-co2-net-zero-means-we-ll-need-it.

11 McKinsey 'Unlocking Asia-Pacific's vast carbon capture potential', 22 February 2023

12 For example, in Japan, the overall storage costs range from approximately JPY 23 to 31 billion for each site. (PDF) Cost Estimates for the CO2 Geological Storage in Deep Saline Aquifers Offshore Japan: A Case Study (researchgate.net)



which are burnt rather than durably stored, there is no CDR. If CO_2 from direct air capture or biomass were used to make concrete, which is a long-lived product, then this could result in CDR but since no geological storage is used, is not CCS.

The distinctions between CCS, CDR and CCU may be illustrated as above.

As discussed, some CCS methodologies result in emission reductions and some in emission removals. In Southeast Asia, offshore geological storage costs are among the lowest in the world. The cost of drilling and well services in Asia is comparatively lower, contributing to enhanced economic competitiveness for carbon storage projects in the region.[13] Conversely, other regions may enjoy a cost advantage in capturing CO_2 due to factors such as the availability of financial and renewable energy resources. For instance, the Middle East and China could be among the least-cost locations for the capture component of DACCS, together with Europe, North Africa and the United States.[14] This supports the idea that in the interests of scaling the solution, investment in the cheapest opportunities for capture and storage (which may be in different jurisdictions) should be pursued.

If the plan is to scale BECCS and DACCS 1,300 times by 2050, it is necessary to face the reality that geological storage facilities and the locations of capture will not be one and the same for many countries. Therefore, the legal, regulatory, GHG accounting and policy frameworks necessary to support and incentivise the capture of CO_2 in one country, the transportation of that CO_2 to a third country, and placing that captured CO_2 in permanent storage facilities in the third country will need to be created. Presently, there is no such methodology anywhere, including in the voluntary carbon markets. Even to the extent there are some methodologies in development, they don't address the transboundary GHG accounting issue adequately and do not at all address the complexity of corresponding adjustment costs under Article 6 (see above).

Does Article 6 have a role in supporting CCS?

Given Article 6 of the Paris Agreement is the main mechanism that enables countries to work together, to enhance the ambitions of their respective nationally determined contributions (**NDCs**), it is legitimate to ask what support for such activities can be achieved using Article 6.

For a Paris Agreement country with unabated industrial emissions, or for emissions from its hard-to abate sectors such as domestic aviation and shipping, emission reductions or removals generated through CCS methodologies could facilitate delivery of both enhanced NDC ambition and its achievement. The absence of domestic geological storage in that country therefore makes the need for a transboundary solution critical.

Article 6 of the Paris Agreement provides for two market mechanisms, namely (i) cooperative approaches under Article 6.2 (**Cooperative Approaches**) and (ii) the mechanism under Article 6.4 (**Art6.4 Mechanism**). The main key difference is that under the Cooperative Approaches, government-to-government (G2G) level arrangements have to be agreed before a mechanism becomes established. This is not required under the Art6.4 Mechanism, as this mechanism is a centralised mechanism operated under the United Nations Framework Convention on Climate Change (**UNFCCC**). The nature of the transboundary problems suggest that the greater flexibility afforded by Cooperative Approaches may be more suitable for identifying policy, legal or governance arrangements needed to develop true cross border CCS methodologies within Article 6.

That said, it is worth acknowledging that a set of UN-level CCS modalities and procedures[15] was developed and approved in 2011 within the Clean Development Mechanism (**CDM**) framework of the Kyoto Protocol. These CCS modalities and procedures went a long way towards addressing issues such as activity boundaries,

13 McKinsey 'Unlocking Asia-Pacific's vast carbon capture potential', 22 February 2023

14 See https://www.iea.org/reports/direct-air-capture-2022/executive-summary.

15 Modalities and procedures for carbon capture and storage in geological formations as clean development mechanism project activities (UNFCCC, 2011).

“It is estimated that China has the potential to account for 25% of cumulative carbon capture globally to 2070. In such circumstances, the application of a corresponding adjustment for a country like India or China could which penalises its NDC achievement could act as a deterrent to it development of CCS solutions via Article 6.”

leakage issues, monitoring of permanence and reversals through leakage from storage sites. Given the similarities between the CDM and the Art6.4 Mechanism, it is therefore not impossible that the 2011 CCS modalities and procedures could be used as a starting point for consideration under the Art 6.4 Mechanism. Of course, the 2011 CCS modalities and procedures did not have to contemplate corresponding adjustment, a key feature of Article 6.

In this context, a corresponding adjustment refers to an accounting adjustment that a Paris Agreement country is required to apply, upon first transfer of an Art 6 Unit (as described below), to the portion of its national GHG inventory covered by its NDC, to produce its emissions balance that is used to track its progress towards meeting its NDC.[16] The concept of a corresponding adjustment is intended to prevent double counting between Paris Agreement Parties, particularly since all Paris Agreement Parties have NDCs. One Article 6 requirement is that a unit (**Art 6 Unit**) issued under a Cooperative Approach or the Art6.4 Mechanism must represent emission reductions or removals, resulting in (i) in the case of a Cooperative Approach, no net increase in global emissions[17] or (ii) in the case of the Art6.4 Mechanism, overall mitigation in global emissions.[18] In other words, an Art 6 Unit must represent a net emissions reduction or removal caused by the activity in respect of which it was generated.

For this reason, the use of CCS in EOR or EGR, which results in more fossil fuel production, may not be compatible with this requirement, unless it could be shown that the use of CCS in EOR or EGR results in net emissions reductions or removals, such as where the CO_2 from the recovered oil or gas was also captured and durably stored or the recovered oil or gas was being used to displace more carbon-intensive fuels such as coal. If this could be demonstrated, then EOR and EGR may play a useful role as economic enablers that help overcome the often-prohibitive cost challenges that impede CCS scaling and establishment. By contrast, demonstrating that the use of CCS in industrial processes or in solutions such as BECCS and DACCS results in net emissions reductions and therefore fulfil this requirement is generally more straightforward than for EOR or EGR. Once again, this highlights the different drivers supporting some CCS methodologies over others.

Given GHG accounting arrangements under Article 6 have been made more complex by the requirement to carry out corresponding adjustments, whether or not the mitigation outcome has taken place inside the host country’s NDC or outside, the cost of the corresponding adjustment causes an obstacle to CCS under Article 6. For most countries, the cost of CCS is among its most costly mitigation solutions. Therefore, it is natural for such activities to not form the basis of the first set of NDCs for most countries. Therefore, such activities typically sit outside the NDCs of most countries. The CBDR principle, which allows countries such as China and India to have different Below 2 Degree Targets under the Paris Agreements compared to western countries, should therefore enable CCS to sit outside their NDC for a number of NDCs in succession. It is estimated that China has the potential to account for 25% of cumulative carbon capture globally to 2070[19]. In such circumstances, the application of a corresponding adjustment for a country like India or China could which penalises its NDC achievement could act as a deterrent to it development of CCS solutions via Article 6.

This is because for the country that captures the CO_2, its ability to benefit from a reduction of its GHG inventory depends on being able to demonstrate that it has been stored permanently. However, given the storage is in a different country, the achievement of the mitigation outcome is, in reality, a shared exercise between countries. The GHG accounting treatment under both Article 6 mechanisms only accommodate situations where the emission reduction or removal occurs within the same country, which, when exported in the form

16 See Decision 2/CMA.3, Annex, paragraph 8, https://unfccc.int/documents/460950

17 Ibid, at paragraphs 18(h)(i), 22(b)(i).

18 See Article 6.4(d) of the Paris Agreement, https://unfccc.int/sites/default/files/english_paris_agreement.pdf

19 IEA, CCUS in Clean Energy Transitions, Regional Opportunities, https://www.iea.org/reports/ccus-in-clean-energy-transitions/regional-opportunities.

of an ITMO, creates a penalty for the exporting country because the storing country now has to make up that exported mitigation outcome (even when it does not impact its ability to perform its NDC).

The Paris Agreement GHG accounting treatment is determined by the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (**2006 Guidelines**) as updated by the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (the **2019 Refinement**).

Under the 2006 Guidelines (as updated by the 2019 Refinement), there is a separate GHG inventory reporting segment for CO_2 transport and storage, in particular, this is split into (i) the transport of CO_2 (through pipelines, ships and others), (ii) injections and storage, and (iii) others. The focus here is on fugitive emissions. As the IPCC clarifies, emissions (and reductions) associated with CO_2 capture should be reported under the IPCC sector in which capture takes place (e.g. Stationary Combustion or Industrial Activities).[20] Although the inventory compiler is only responsible for reporting on the effect of operations in its jurisdiction, he/she must record cross-border transfers of CO_2 for cross-checking and QA/QC purposes.[21]

Applying the 2006 Guidelines as updated by the 2019 Refinement to a cross-border example, where industrial gas emissions from the burning of fossil fuels (in particular for power plant-related activities) in one Paris Agreement country (**Country A**) were captured and transported to another Paris Agreement country (**Country B**) for storage in geologic formations, which country should report the benefit of the emission reduction that this has achieved?

The 2006 Guidelines and the 2019 Refinement state that Country A should report an export of CO_2 to Country B in this scenario and that Country B should record the import for such CO_2.[22] Although the explanation in the 2006 Guidelines and the 2019 Refinement is quite limited, a possible model for this would be the following:

1. Country A records a reduction in its GHG inventory and emissions balance. Since the emissions sources[23] are located in the national territory over which Country A has jurisdiction,[24] the emissions reductions would be attributed to Country A, which would report only the amount of emissions net of the captured CO_2[25];
2. Country B would record the imported CO_2 as part of the inventory quality assurance/ quality control of the whole CCS system.[26] However, there should be no effect of such imported CO_2 on Country B's GHG inventory unless there are fugitive emissions.

The problem with this is that it enables a -1 to be reporting in Country A's inventory (thereby potentially benefitting its NDC) but there is no international transfer of this -1. In short, Country A's inventory reduction is deemed to be achieved and used in Country A and is not internationally transferred to Country B. Although this may therefore support an economic GHG accounting based transaction between two countries that could support the economic cost of CCS (noting also that the risk of GHG accounting increases from fugitive emissions during storage lies with Country B), it may not meet the criteria for the creation of an emission reduction or removal that is capable of being recognised as an ITMO as there is no international transfer of an emission reduction or removal. It may be possible to construe the emissions reduction achieved by Country A in this way as an ITMO if Country A wishes to transfer the emissions reduction to another country (**Country C**) (as recognised under a cooperative approach between Country A and Country C).

Therefore, absent further refinement of the 2006 Guidelines, it may be that only those CCS activities that involve capture, transport and storage of GHG emissions or removals within the same jurisdiction can be supported under Article 6. However, the countries that meet these criteria are limited and they tend to be in developed countries with high GHG emissions anyway (such as the USA) meaning that if they can fund the CCS abatement solution, they will not share that abatement benefit (in the form of an ITMO) with another country. Ironically, therefore, the countries that need the greatest support to develop their CCS infrastructure and who also may happen to benefit from the most cost-effective CCS development ability (e.g. in the Asia Pacific region), cannot currently use Article 6 to help fund their CCS infrastructure. Further, even where there was a coincidence of high industrial emissions and geological storage (e.g. in China, Indonesia and Malaysia) and where the export of ITMOs could have enabled financial support to flow to such countries to develop their CCS infrastructure, the application of corresponding adjustment penalties (notwithstanding such CCS activities being outside their NDC) would discourage such financing flows unless the price paid for such ITMOs were significantly high by the buying country.

20 See Table 5.1 of Volume 2 of IPCC 2006.

21 See Section 5.7.1 of Volume 2 of IPCC 2006.

22 See Section 2.3.4 and Section 5.10 of Volume 2 of IPCC 2006, and Section 8.2.1 of Volume 1 of IPCC 2019.

23 The IPCC defines a *"source"* as *"any process or activity which releases a greenhouse gas (GHG), an aerosol or a precursor of a GHG into the atmosphere"*, https://apps.ipcc.ch/glossary/.

24 Under Section 1.1 of Volume 1 of the 2019 Refinement to IPCC 2006, national inventories generally include greenhouse gas emissions and removals taking place within the national territory and offshore areas over which the country has jurisdiction, https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/1_Volume1/19R_V1_Ch01_Introduction.pdf

25 Under Section 8.2.1 of Volume 1 of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories ("IPCC 2019"), both captured biogenic and fossil CO2 should not be added to the total emissions, i.e. net emissions should be reported, https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/1_Volume1/19R_V1_Ch08_Reporting_Guidance.pdf; see also Equation 2.7 in Section 2.3.4 of Volume 2 of IPCC 2006, https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf.

26 See Section 5.9 of Volume 2 of IPCC 2006.

Reform Article 6 or develop other forms of economic cooperation?

Due to the difficulty of demonstrating an international transfer of emissions reductions or removals in cross-border CCS cooperation, Article 6 may not be a feasible option for cross-border CCS cooperation in the absence of further refinements to the Article 6 rules and unless different approaches are taken[27]. Further, if there are to be further refinements to the Article 6 rules, the blanket requirement to apply a corresponding adjustment upon first transfer may need to be revisited to take into consideration the fact that CCS, and particularly BECCS and DACCS, go beyond or are entirely outside the sectors covered by the NDCs of most Paris Agreement Parties.

For completeness, we note that an ITMO can also include mitigation co-benefits resulting from adaptation actions and/or economic diversification plans or the means to achieve them when internationally transferred.[28] However, such mitigation co-benefits cannot stand on their own and must accompany an emissions reduction or removal that is internationally transferred. Without an international transfer of an emissions reduction or removal, CCS cannot result in an ITMO even if it could be described as a mitigation co-benefit in this sense.

Alternatively, Paris Agreement Parties may develop other mechanisms for cross-border CCS cooperation. Such mechanisms could take the form of financial support or payments by the capturing country for CO_2 storage services by the storing country, which would be necessary to cover the costs of importing and storing CO_2, as well as the risks of emissions from storage which the 2006 Guidelines and the 2019 Refinement place on the storing country. Without further reform to Article 6, a mechanism that incentivizes the storing country to assist the capturing country to meet the latter's NDC without any international transfer of emissions reductions or removals (which would require a corresponding adjustment) may have to be contemplated. There have been various proposals about how to incentivize cross-border CCS cooperation which do not rely on Article 6.[29]

27 See e.g. the discussions on "Model 3" in IEA, IEAGHG Technical Report 2023 on Integrating CCS in international cooperation and carbon markets under Article 6 of the Paris Agreement, https://ieaghg.org/ccs-resources/blog/new-ieaghg-technical-report-2023-01-integrating-ccs-in-international-cooperation-and-carbon-markets-under-article-6-of-the-paris-agreement. Under Model 3, the intention is to create a multilateral CCS club of parties and build upon the adoption storage targets in NDCs and is underpinned by the concept of a 'carbon storage unit'.

28 See Decision 2/CMA.3, Annex, Paragraph 1.

29 See e.g. the discussions on "Model 1" and "Model 2" in IEA, IEAGHG Technical Report 2023 on Integrating CCS in international cooperation and carbon markets under Article 6 of the Paris Agreement, https://ieaghg.org/ccs-resources/blog/new-ieaghg-technical-report-2023-01-integrating-ccs-in-international-cooperation-and-carbon-markets-under-article-6-of-the-paris-agreement.

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ANNEX TO PAPER

	Abbreviation	Meaning
Carbon dioxide capture and storage	CCS	A process in which a relatively pure stream of carbon dioxide from industrial and energy-related sources is separated (captured), conditioned, compressed and transported to a storage location for long-term isolation from the atmosphere.
Carbon dioxide capture and utilisation	CCU	A process in which carbon dioxide is captured and the carbon then used in a product. CCU is sometimes referred to as carbon dioxide capture and use (CCUS).
Carbon dioxide removal	CDR	Anthropogenic (i.e. resulting from or produced by human activities) activities removing CO_2 from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products but excludes natural CO2 uptake not directly caused by human activities.

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